



Enabling Exploration: NASA's Technology Needs

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SPACE EXPLORATION: THE NEXT STEPS



The end of an era July 21, 2011:
30 years of Space Shuttle Exploration

NASA is changing its approach to Space Exploration

Strategy:

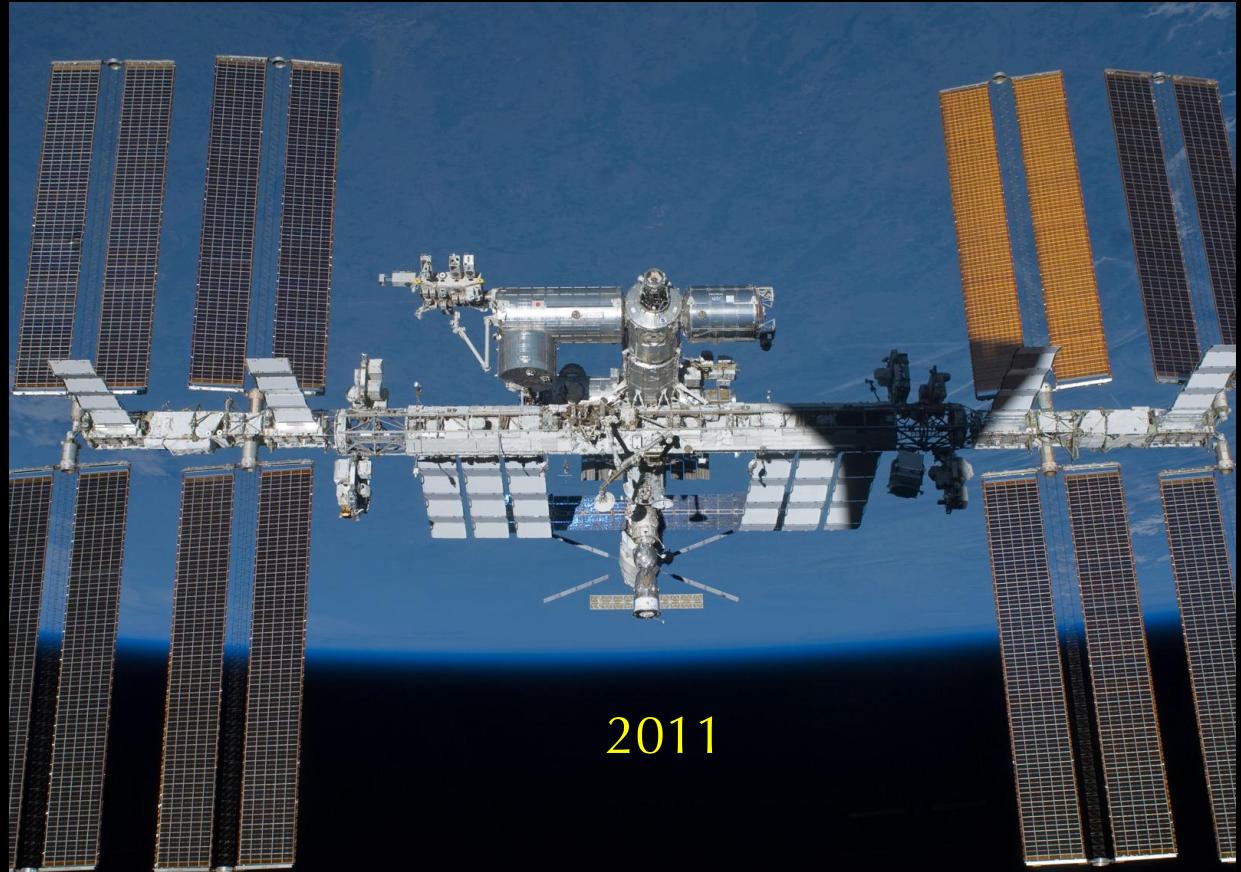
- ✧ Use the International Space Station as a research lab and test bed for new technologies
- ✧ Foster a commercial industry to take us to and from low Earth orbit
- ✧ Develop technologies to take humans to an asteroid and eventually to Mars



International Space Station



1998



2011

An incredible orbiting research lab

1.5 billion statute miles +

16 nations

202 astronauts

74 Russian vehicles, 37 space shuttles, two European and two Japanese vehicles

Foster U.S. Industry to Carry People and Cargo to/from Low Earth Orbit



Sierra Nevada
Dream Chaser



Boeing
CST-100



Space-X
Falcon 9 and Dragon



Blue Origin

Space Tourism: non-NASA Ventures

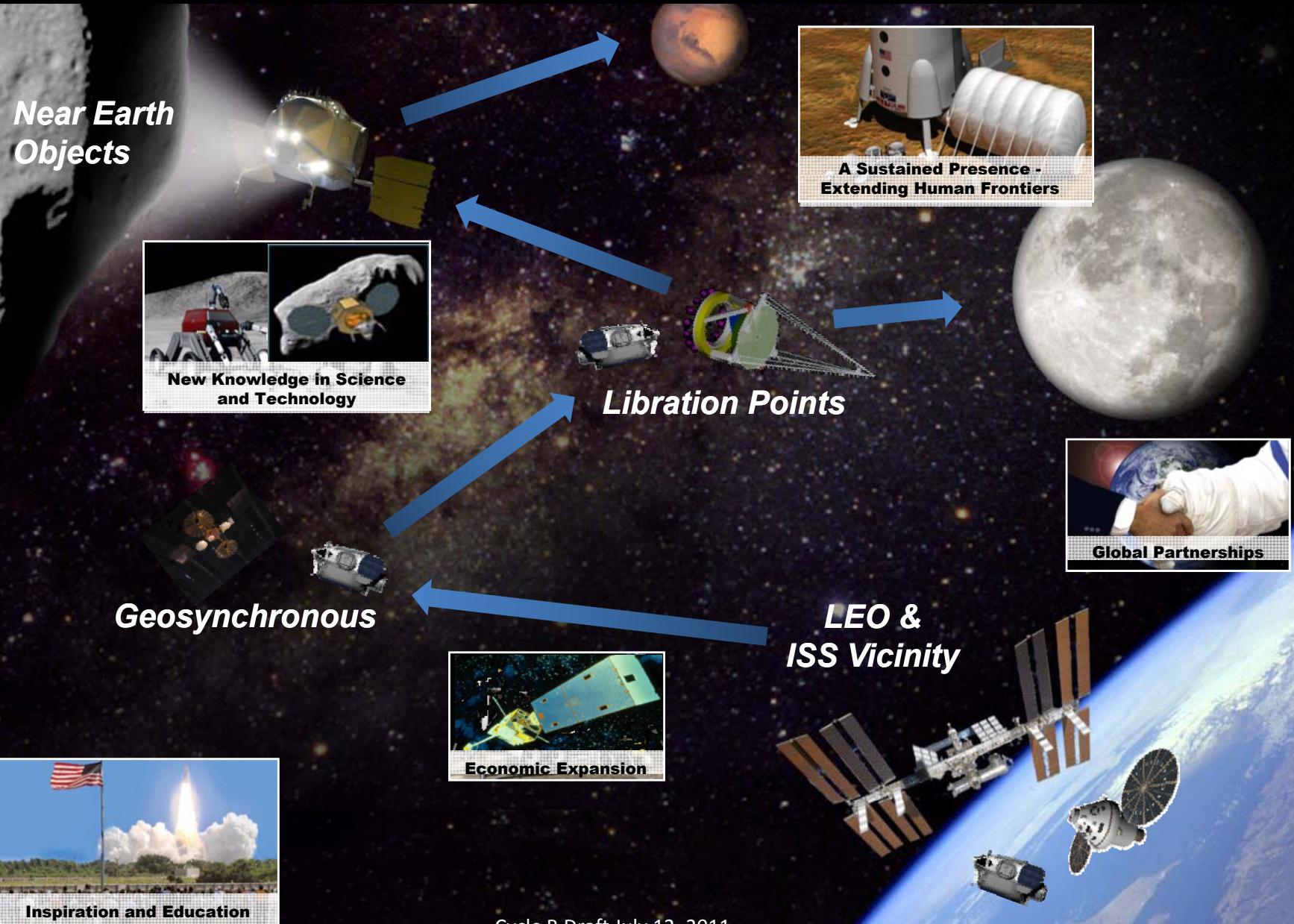


Virgin Galactic



XCOR Aerospace

NASA is Building the Capability to Go Further





Tomorrow's missions are demanding more ...



More places

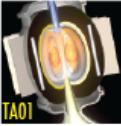
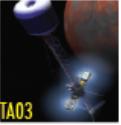
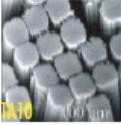
More data processing

More autonomy



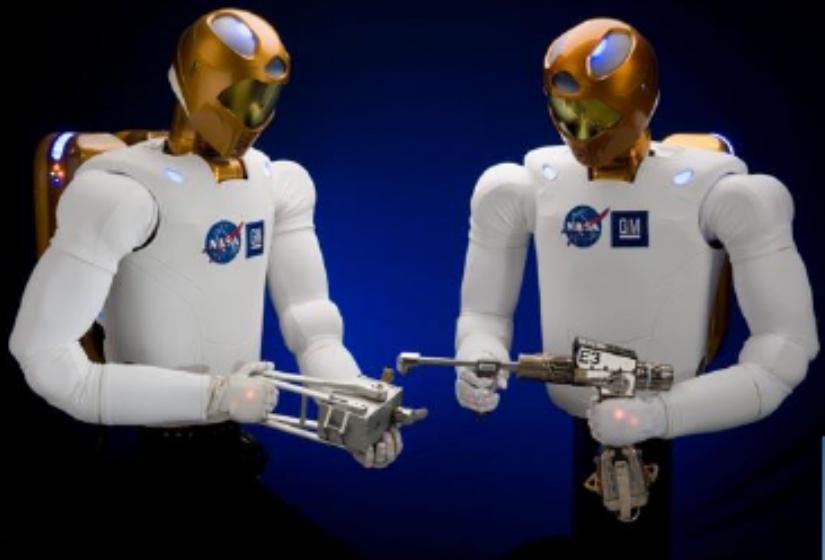
WHAT TECHNOLOGIES ARE NEEDED?

14 Technology Areas

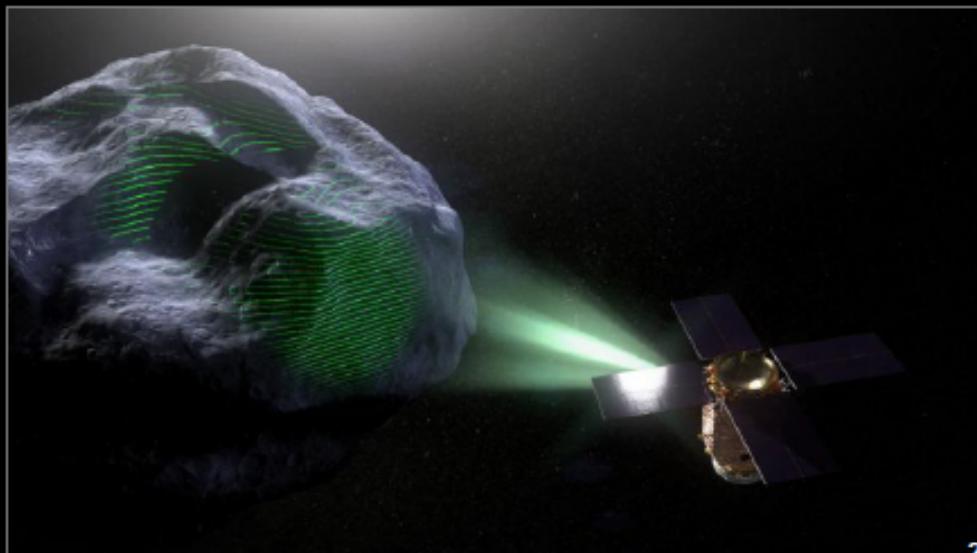
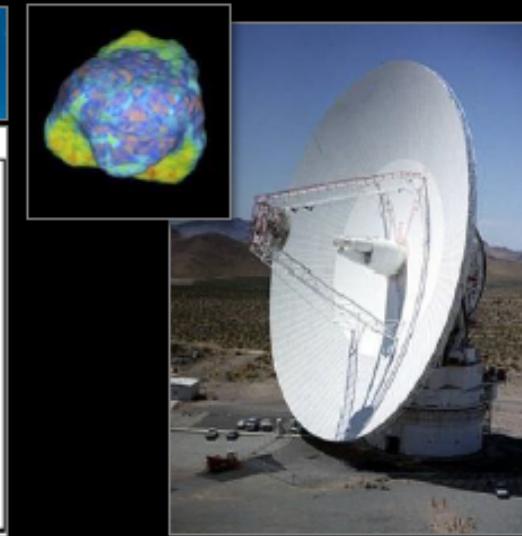
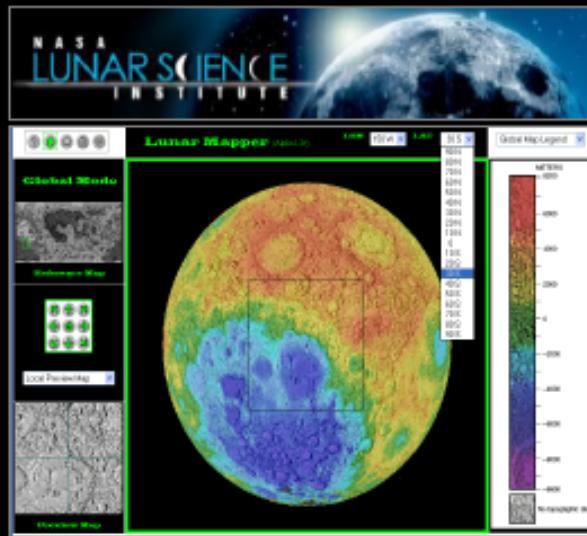
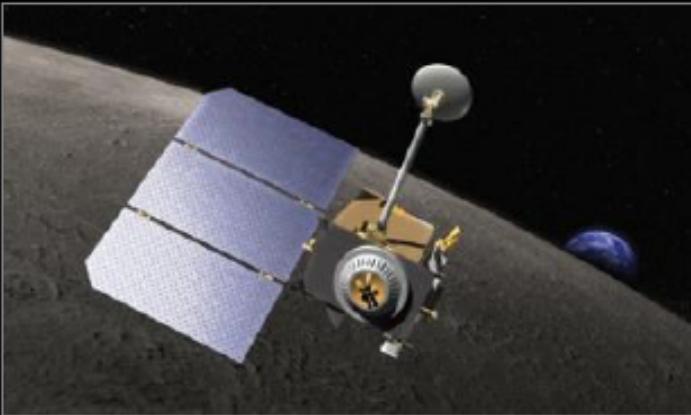
TA01	 TA01	• Launch Propulsion Systems	TA08	 TA08	• Science Instruments, Observatories & Sensor Systems
TA02	 TA02	• In-Space Propulsion Technologies	TA09	 TA09	• Entry, Descent & Landing Systems
TA03	 TA03	• Space Power & Energy Storage	TA10	 TA10	• Nanotechnology
TA04	 TA04	• Robotics, Tele-robotics & Autonomous Systems	TA11	 TA11	• Modeling, Simulation, Information Technology & Processing
TA05	 TA05	• Communication & Navigation	TA12	 TA12	• Materials, Structures, Mechanical Systems & Manufacturing
TA06	 TA06	• Human Health, Life Support & Habitation Systems	TA13	 TA13	• Ground & Launch Systems Processing
TA07	 TA07	• Human Exploration Destination Systems	TA14	 TA14	• Thermal Management Systems

What new capabilities can be created?

Technology Developments



Robotic Precursor Missions Pave the Way for Future Human Exploration Missions

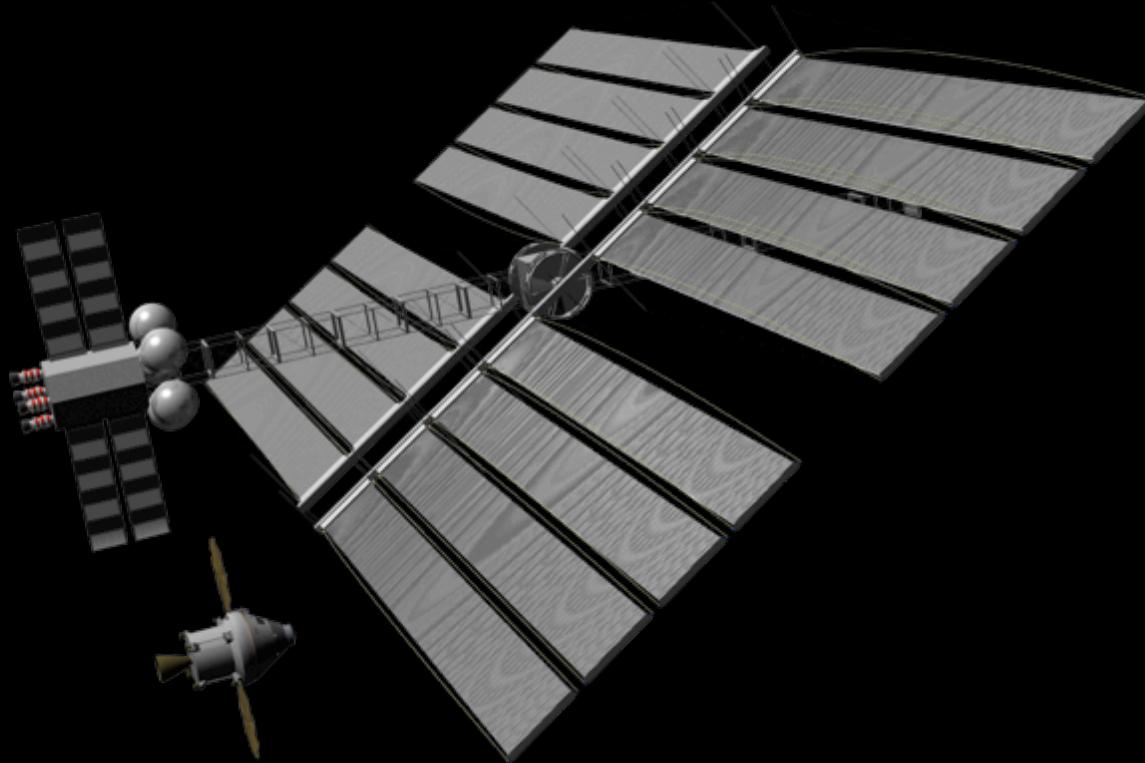


Orion Multi-Purpose Crew Vehicle and Space Launch System



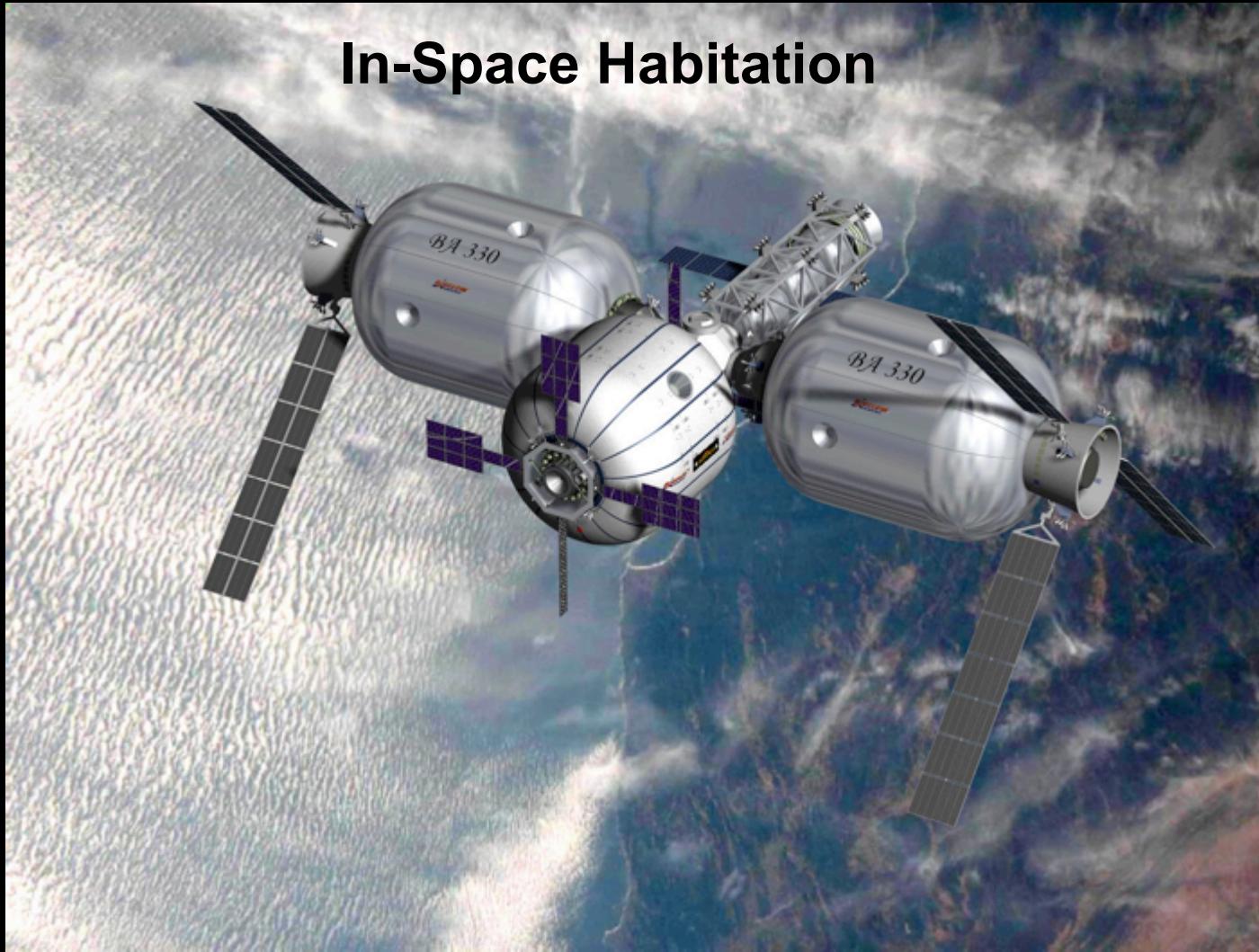


Solar Electric Propulsion





In-Space Habitation



Planetary Transportation System





NASA Ames Overview

Technical Scope::

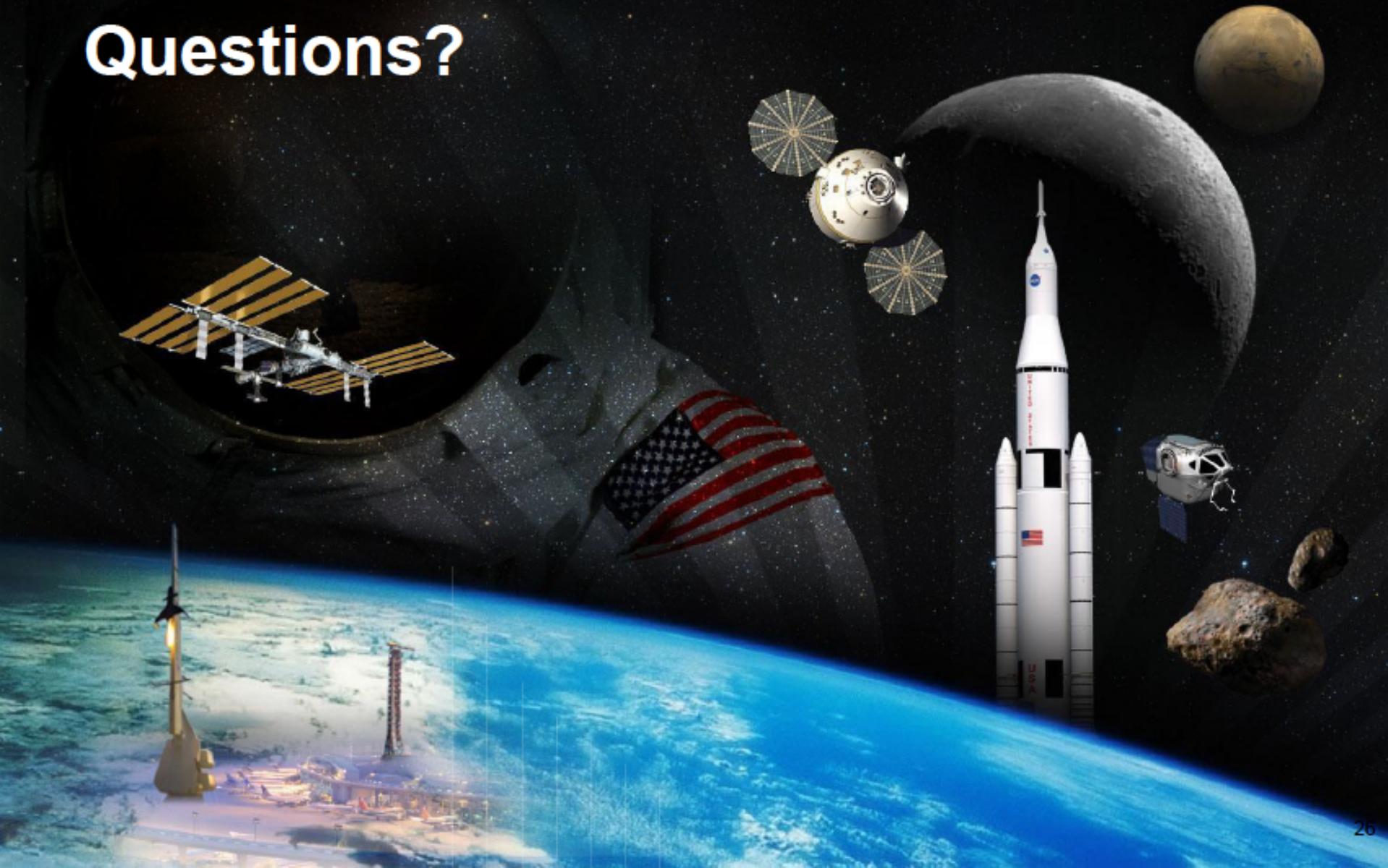
- **Science (Earth-Life-Space)**
- **Astrobiology**
- **Science Missions**
- **Intelligent Systems**
- **High End Computing**
- **Human System Integration**
- **Small Satellites**
- **Aviation and Aeronautics**
- **Innovative Collaborations**

- **2400 Employees**
- **\$700+ M Annual Budgett**





Questions?



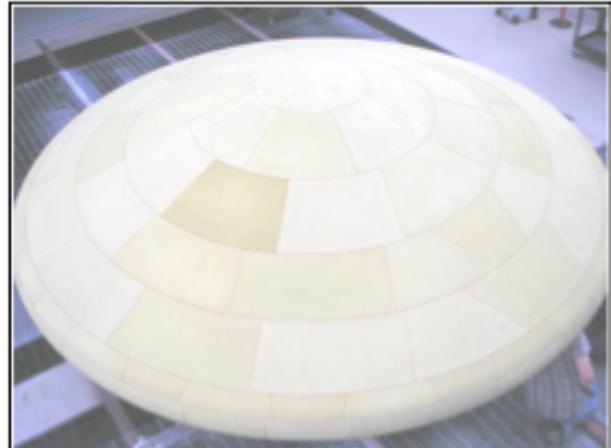


Thermal Protection Systems Research

- **State of the art low density carbon ablators are used for current mission but have challenges**
 - Low strain to failure
 - Brittle char
 - Needs strain isolation pads and gap fillers in tiled configurations



Orion Heat Shield
(5 m diameter)

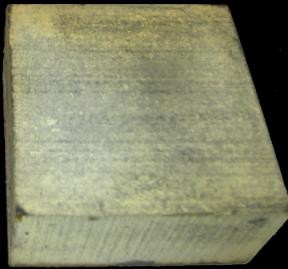


MSL Heat Shield
(4.5 m diameter)



Thermal Protection Materials Research at Ames

Rigid Ablators

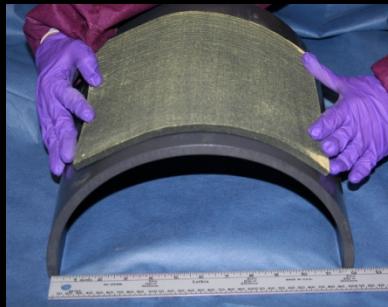


Advanced PICA
-like ablators



Graded Ablators

Conformable Ablators



Conformable PICA

Flexible Ablators



Flexible PICA

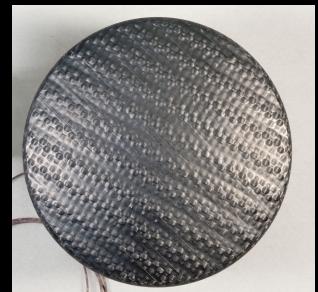


Flexible SIRCA

Woven TPS



Mid density TPS



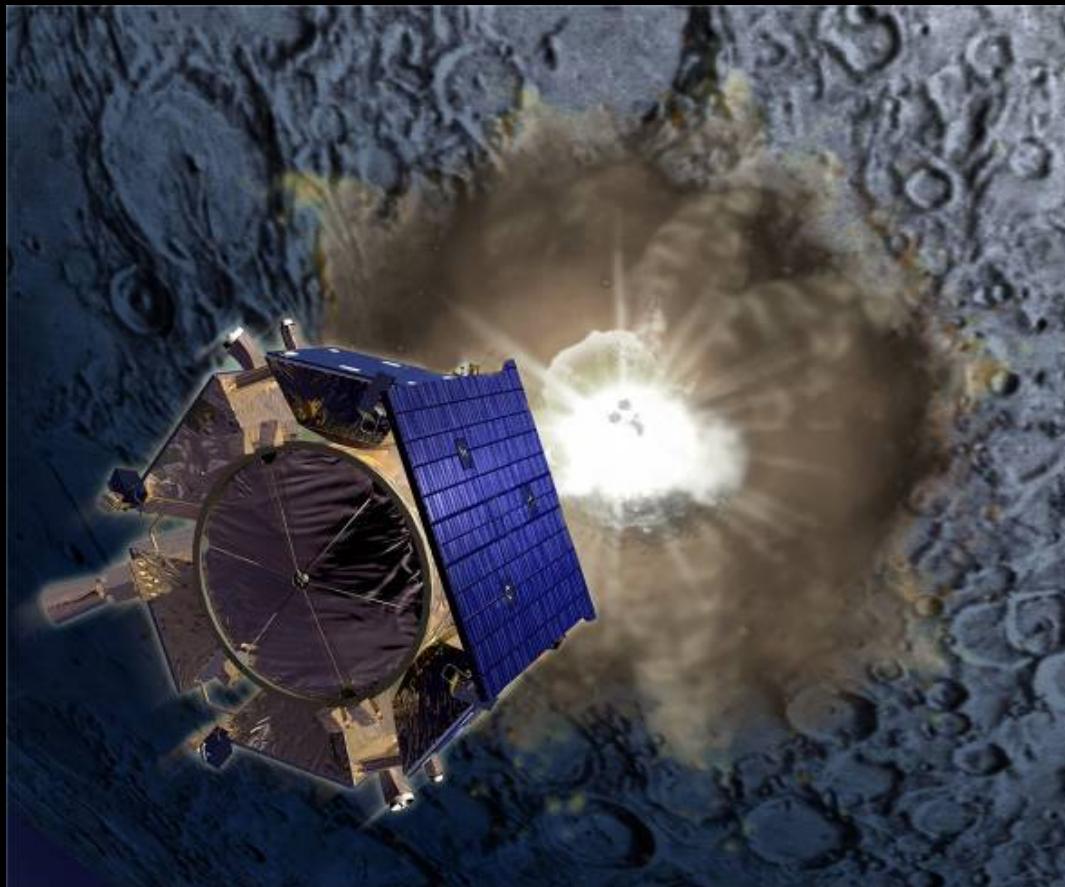
Carbon phenolic replacement



SCIENCE HIGHLIGHTS

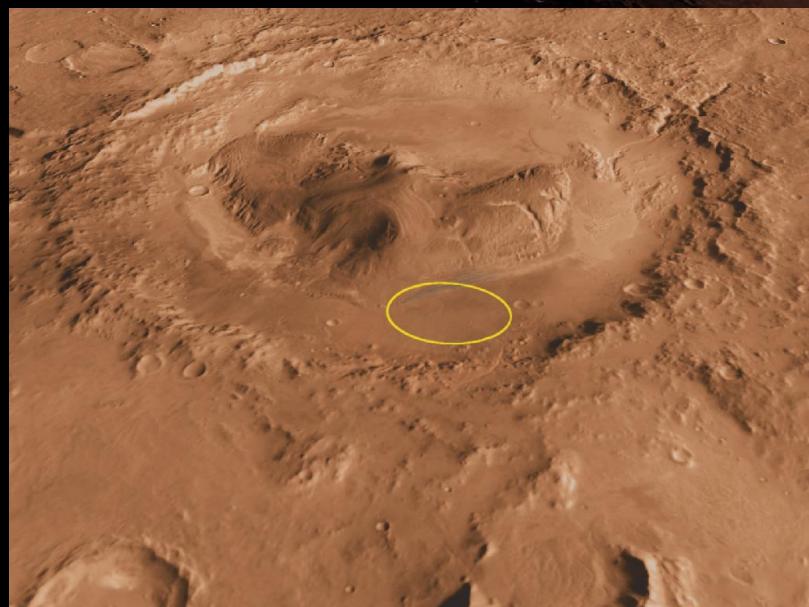


Water on the Moon - LCROSS

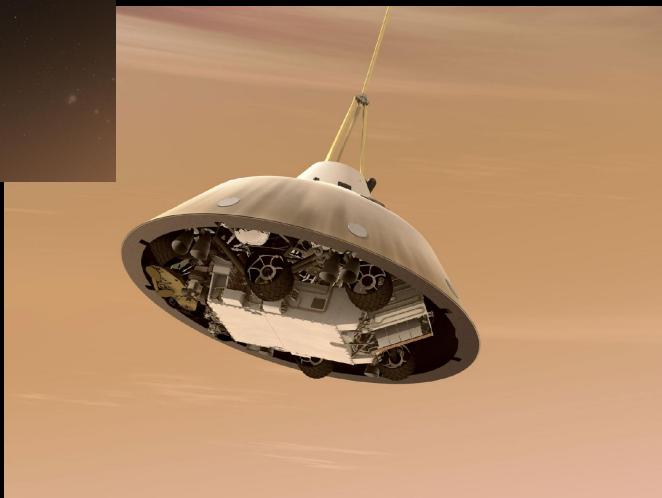
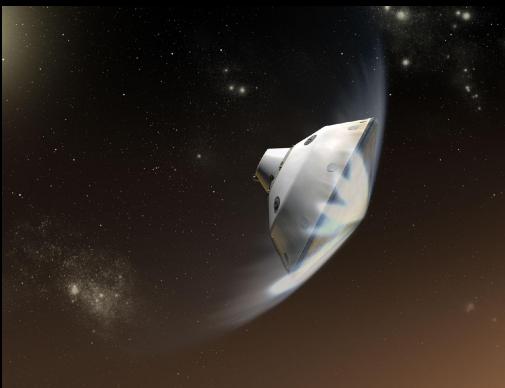


Changed our understanding of the moon

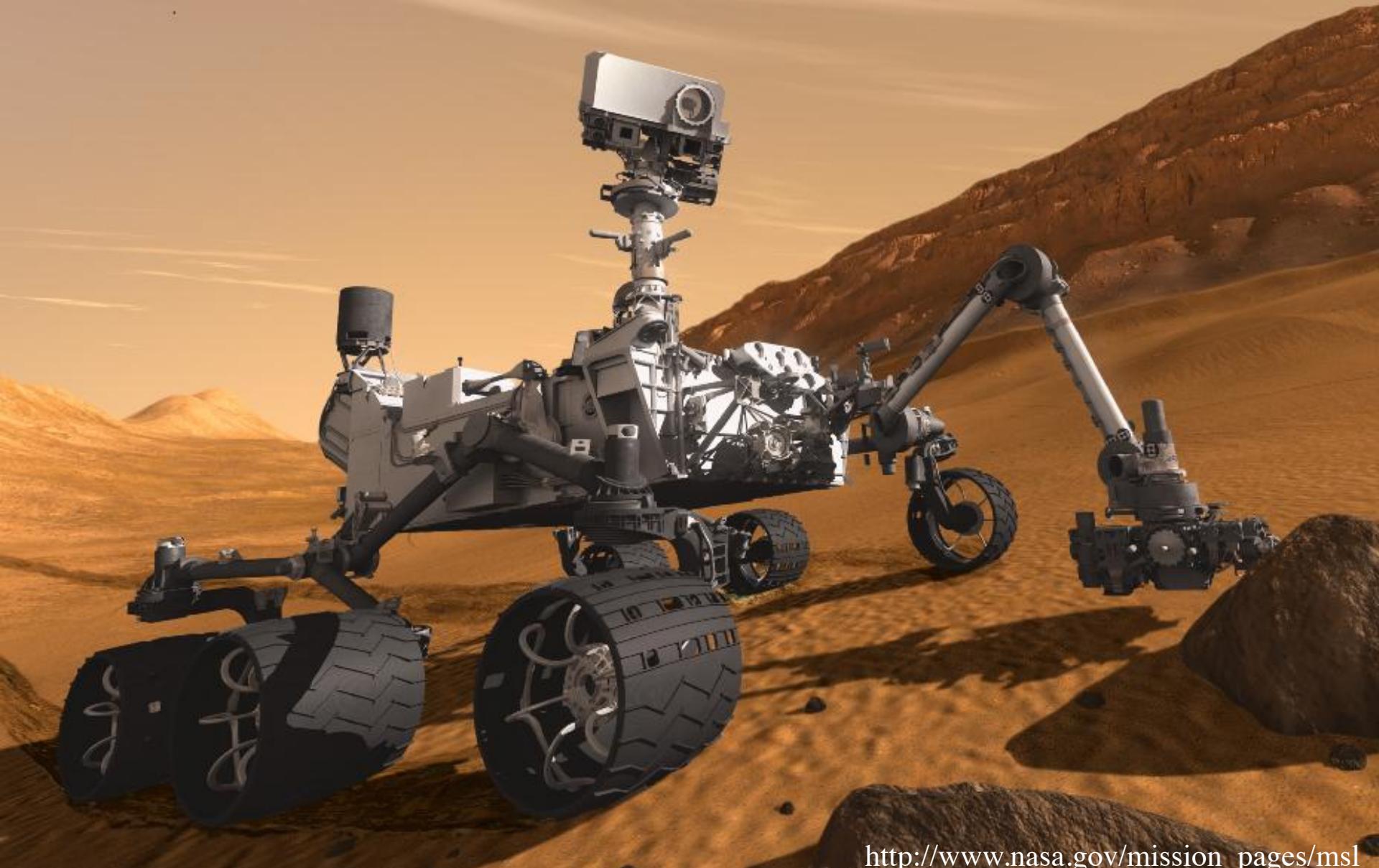
Destination Mars: Gale Crater

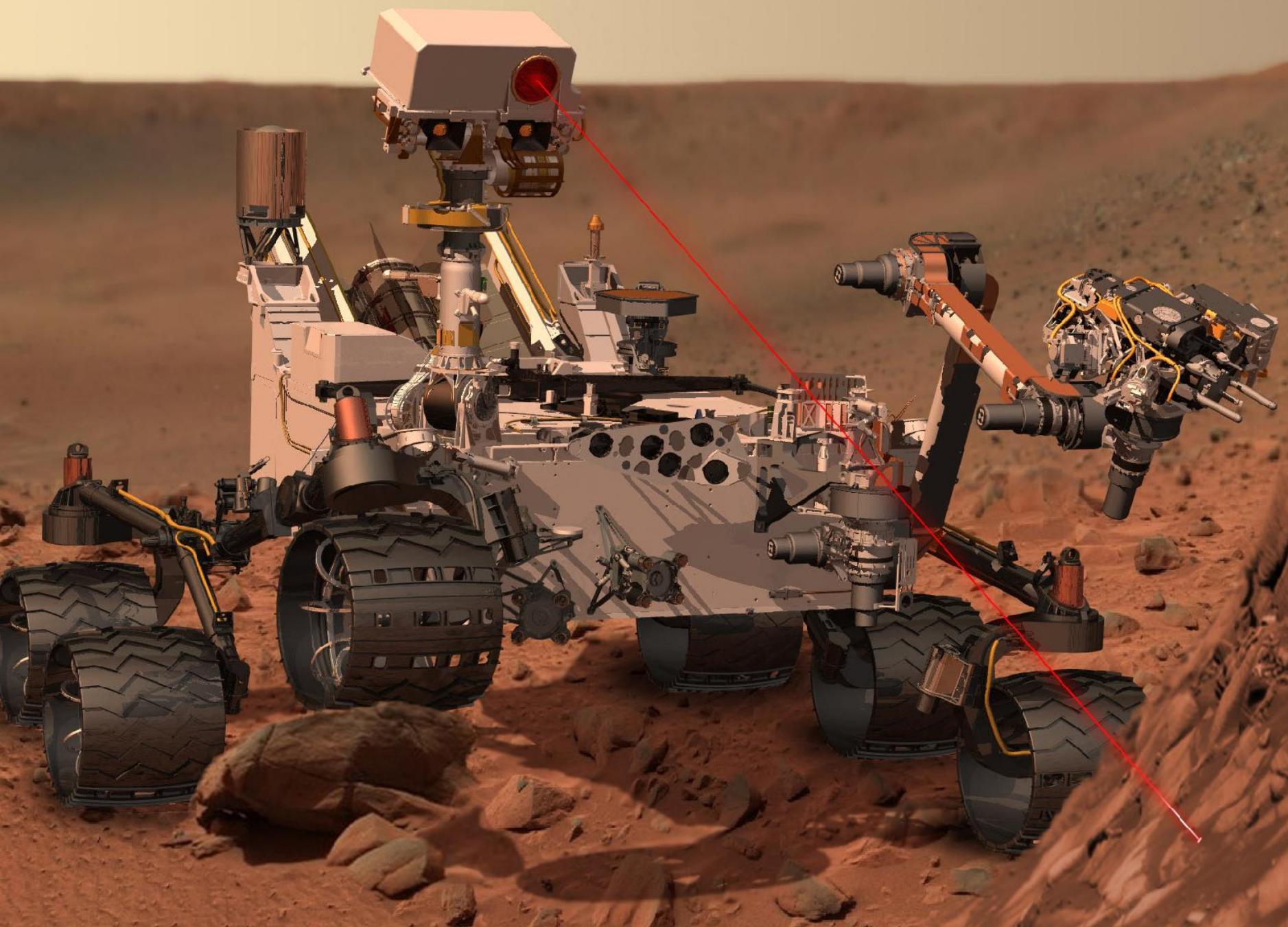


New Landing System: Mars Sky Crane



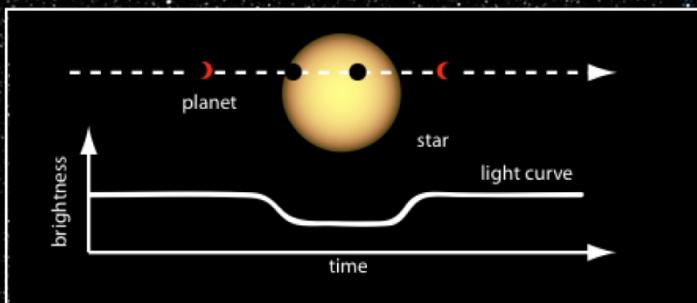
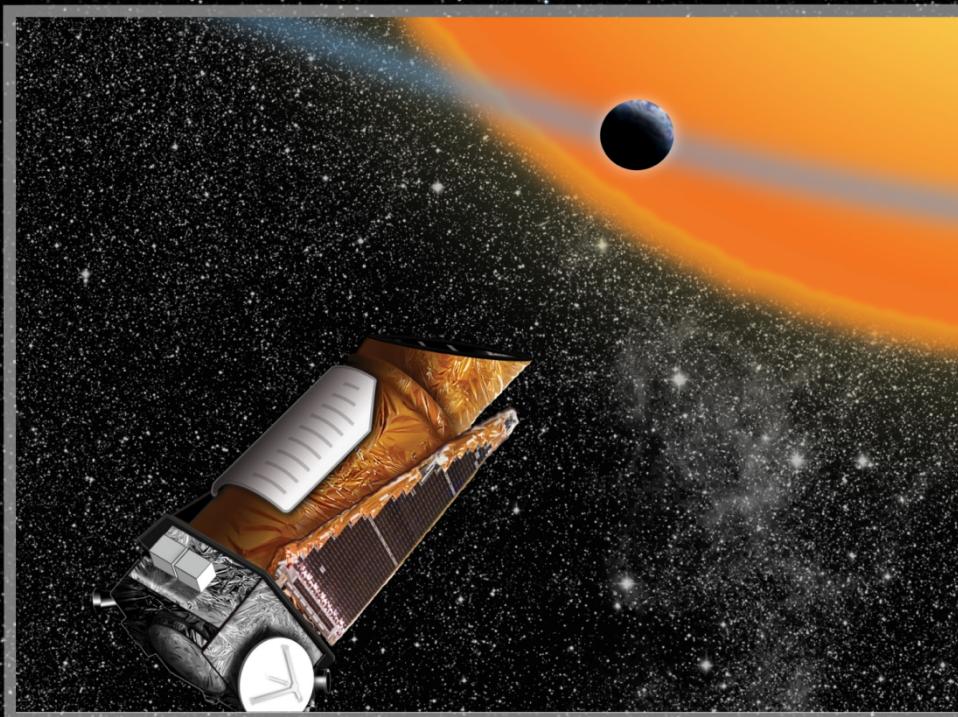
Curiosity – The Next Mars Rover

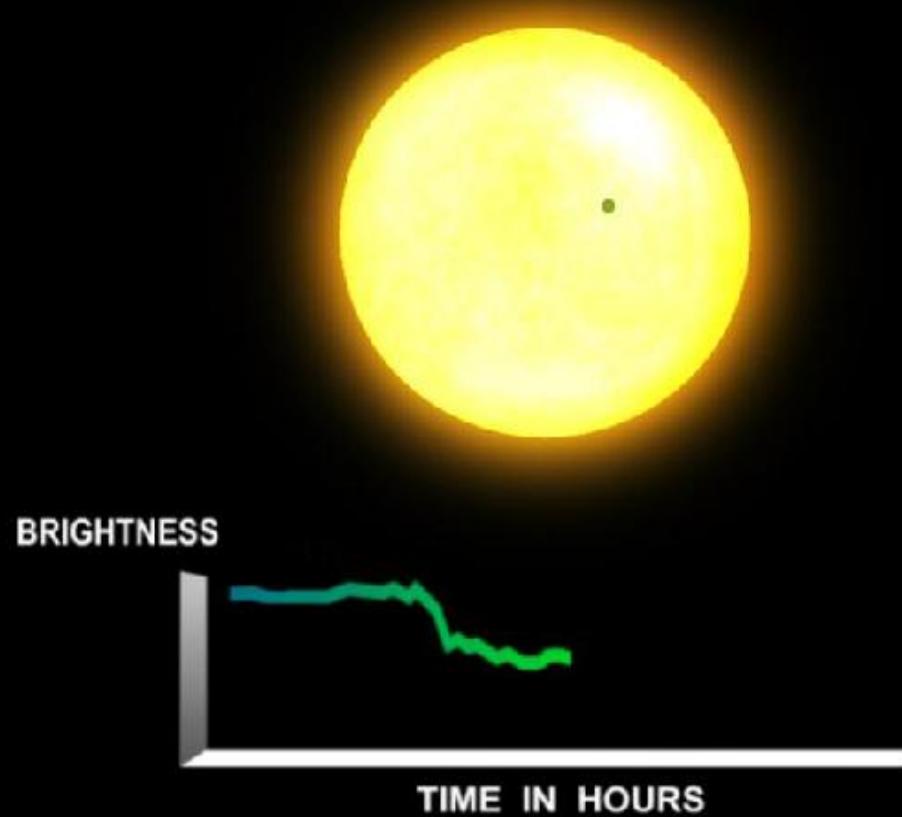




Kepler Mission

*The determination of the frequency of Earth-size & larger planets
in and near the habitable zone of solar-like stars*





Kepler uses light curves to detect new planets

Locations of Kepler Planet Candidates

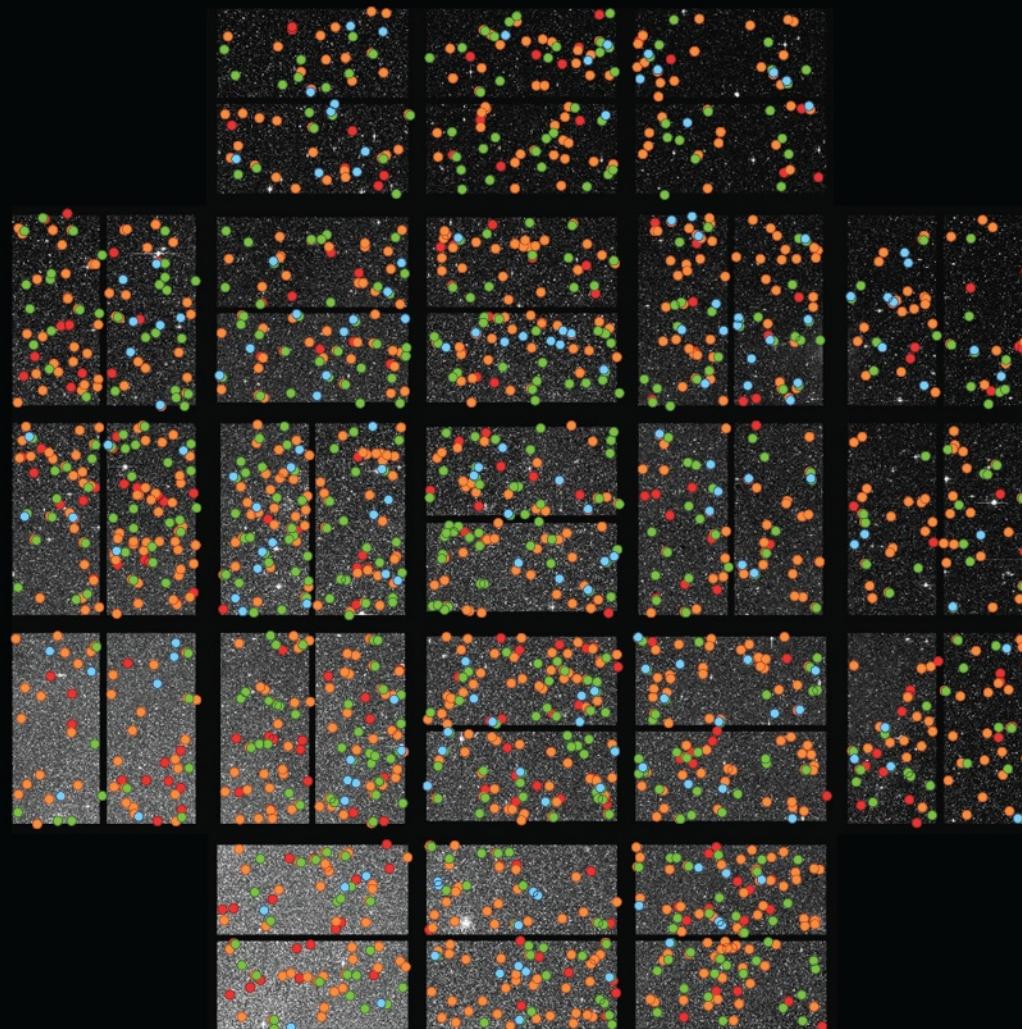
As of December 5, 2011

● Earth-size

● Super-Earth size
1.25 - 2.0 Earth-size

● Neptune-size
2.0 - 6.0 Earth-size

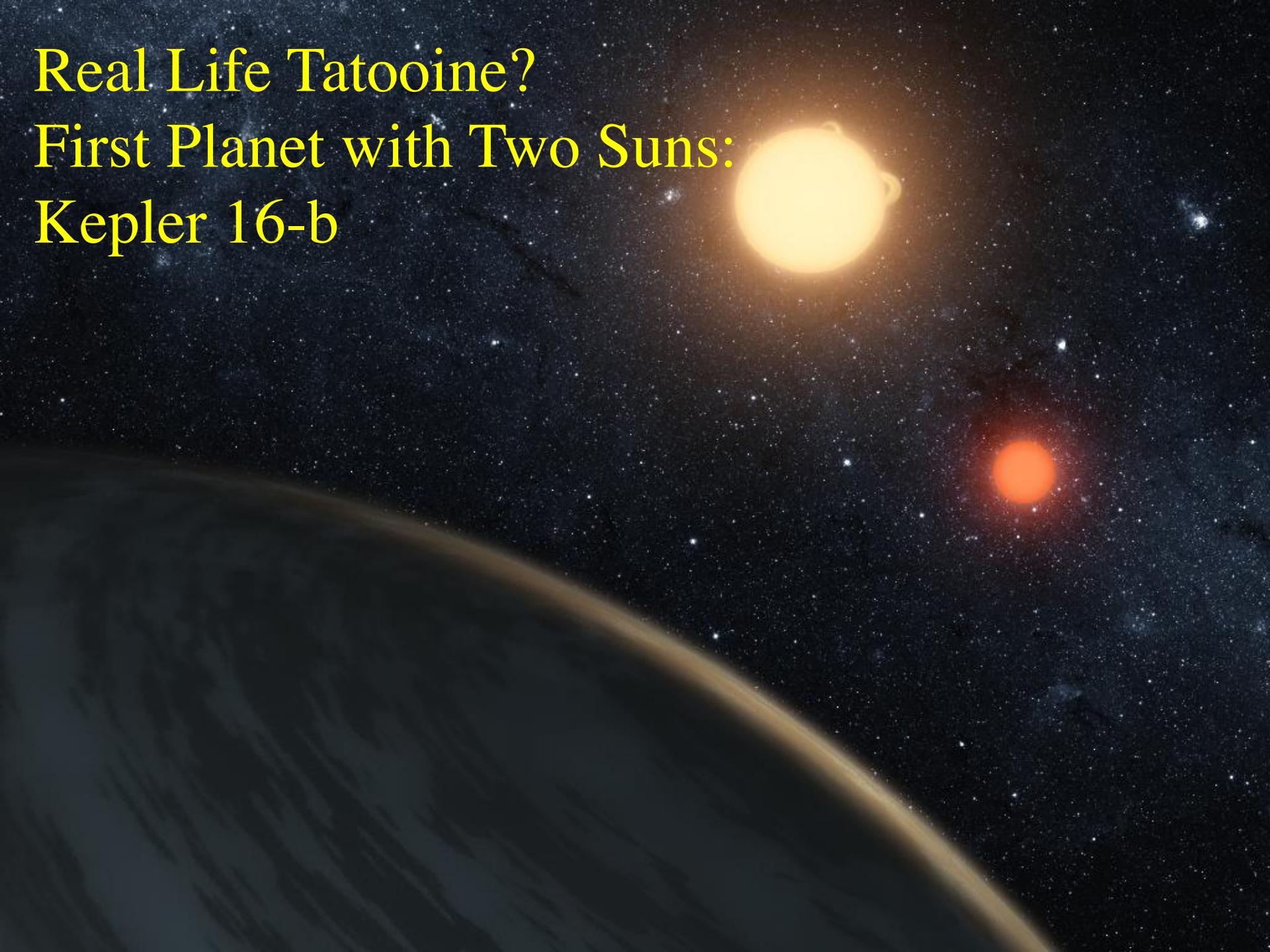
● Giant-planet size
6.0 - 22 Earth-size

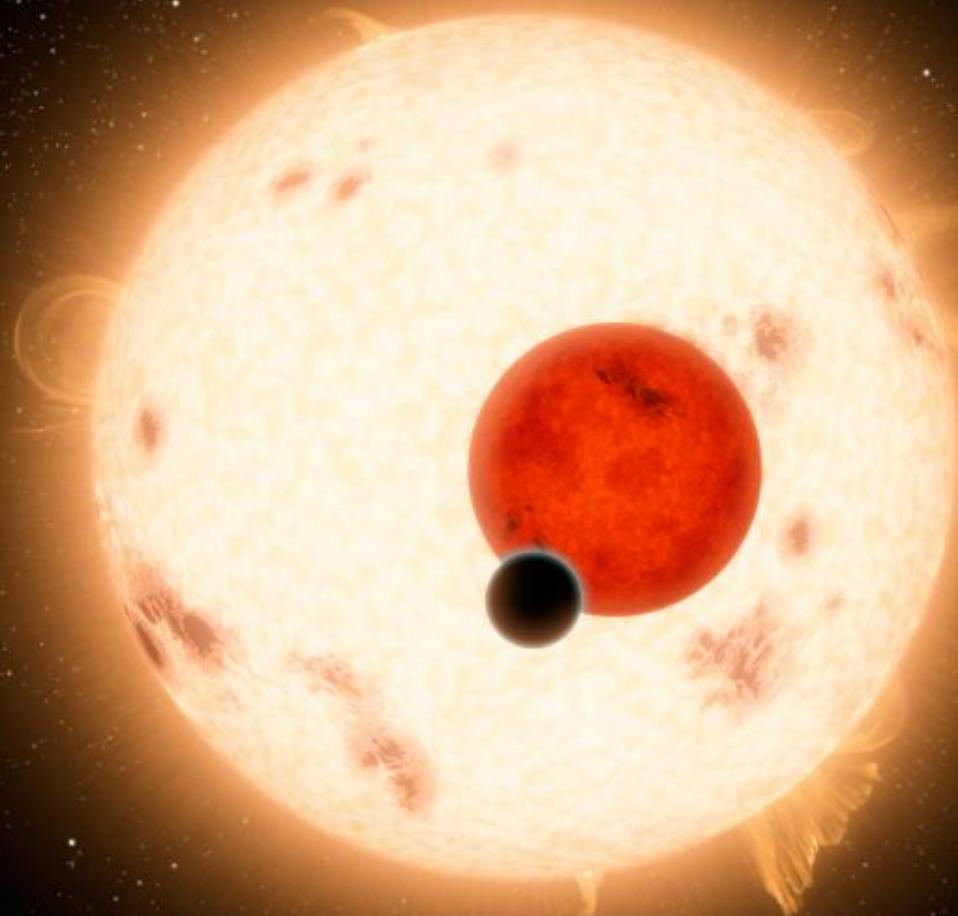


Real Life Tatooine?

First Planet with Two Suns:

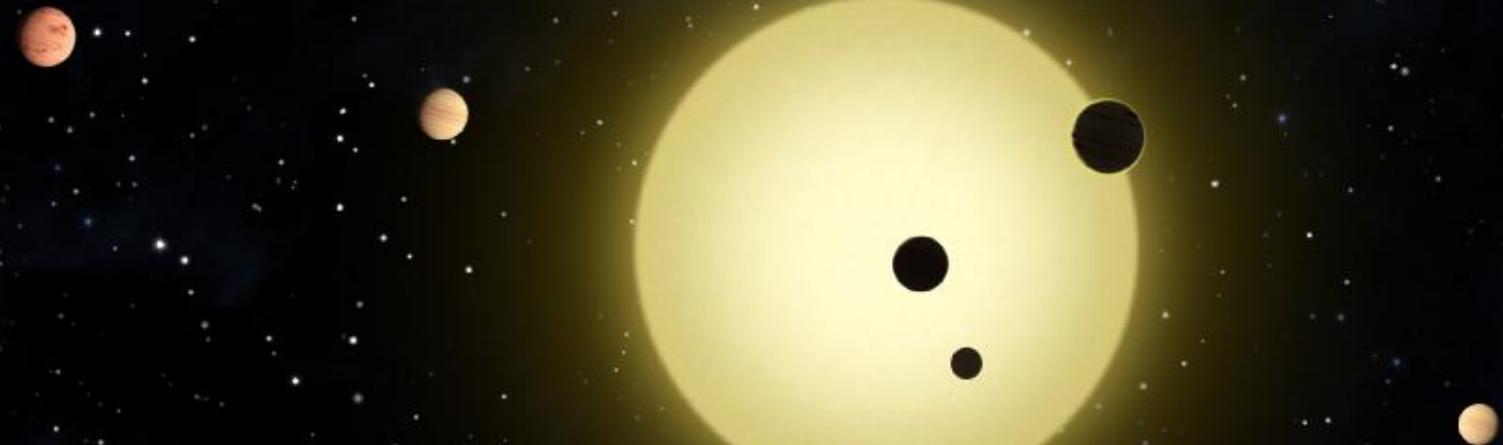
Kepler 16-b

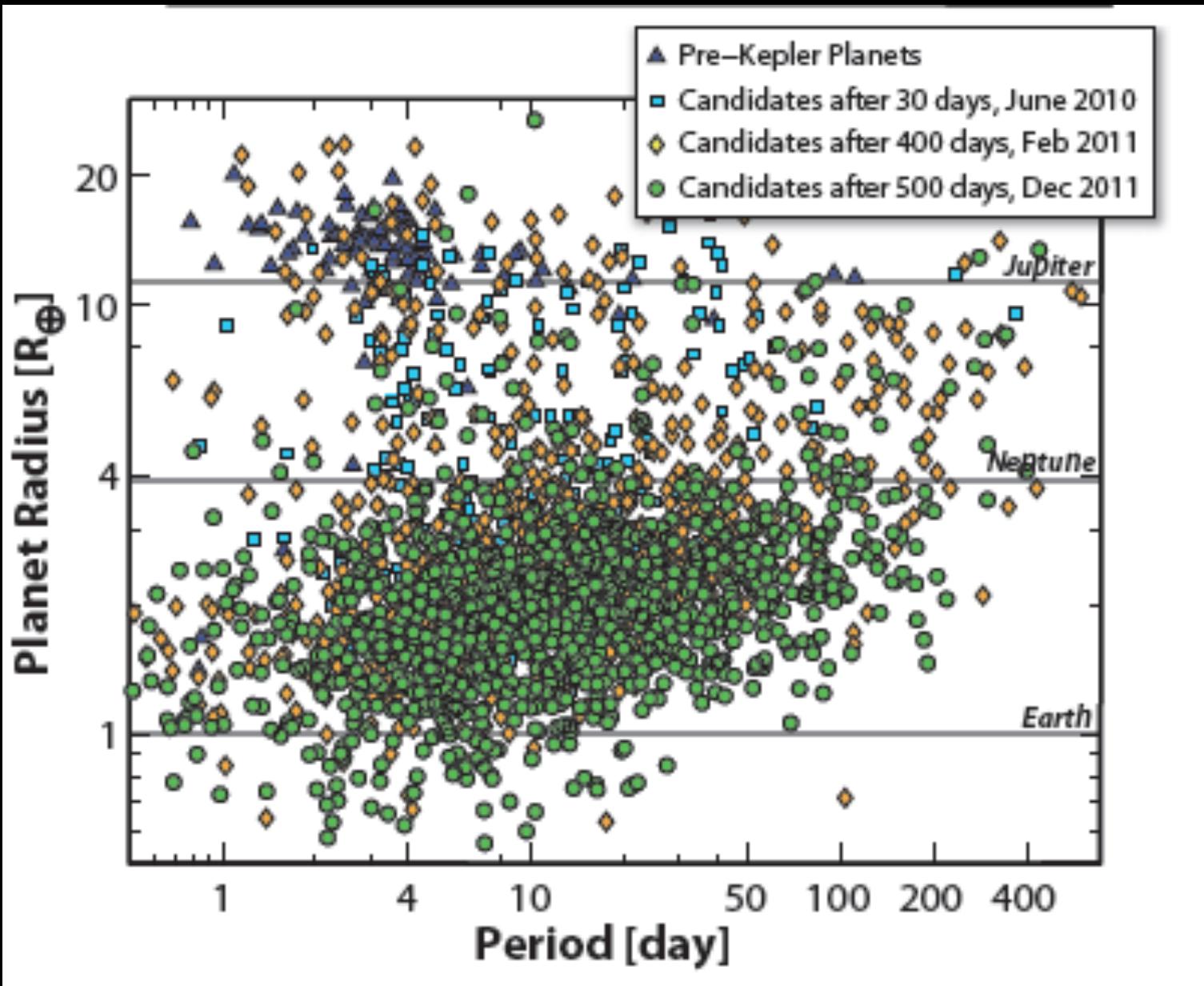




Another View of the “Tatooine” Planet: Kepler 16-b

Out of this world Solar System orbiting Kepler 11







Looking Towards the Future

- ISS will be the centerpiece of human spaceflight activities until at least 2020
- Research and technology breakthroughs aboard ISS will facilitate travel to destinations beyond low Earth orbit
- Destinations for human exploration remain ambitious: the Moon, asteroids and Mars
- Continue to undertake world-class science missions to observe our planet, reach destinations throughout the solar system and peer even deeper into the universe
- Advance aeronautics research to create a safer, more environmentally friendly and efficient air travel network for the Next Generation Air Transportation System
- Continue to inspire the next generation of scientists, engineers and astronauts by focusing on STEM education initiatives





Student Opportunities: Many student internship, fellowship, and post-doc opportunities across NASA



<http://intern.nasa.gov>

<http://eap.usra.edu>

<http://nasa.orau.org/postdoc>



Questions?

